

Figure 4 was made during a period in which two very short power outages occurred, and the data is surely subject to interpretation. However, since these data were not used directly anywhere in the report, no effort was made to repeat the measurement.

5. DATA SUMMARY AND CONCLUSIONS

This section contains a summary of all of the measurements made, using the calculated rms value of the noise. Although the rms value is only a single point used to characterize the whole APD--and, therefore, must necessarily be a somewhat incomplete characterization--the rms value is a measure of the total energy radiated at each frequency and is probably the most significant single parameter which describes the noise.

The amplitude scale on the preceding APD and ACR graphs is plotted in dBm at the receiving antenna terminals. The rms values from the APD Figures are recorded in the 4th column of Table 2 and represent the rms power in a 10 kHz bandwidth at the antenna terminals. The amount of energy in the electromagnetic field near the measurement antenna can be calculated only by making several assumptions. First, one must know the gain of the antenna (or some equivalent "antenna factor") at each frequency of measurement. Although the gain of the antenna may be measured, more critical assumptions must be made about the directional qualities with which the noise is radiated from the cars and the relationship between the electric and the magnetic components of the noise in the near field. Neither of these questions was considered in this set of measurements. There was no effort to locate maximum or minimum levels of noise by moving the measurement antenna to different sites near the cars. In addition, there was no attempt made to measure the energy in the magnetic field of the noise. Since the measurement antenna was in the near field of the cars at the lowest two frequencies (where there is no fixed ratio between the energy in the electric and magnetic fields), it is possible that substantial measurement inaccuracies may have resulted.

Nevertheless, lacking sufficient data to make a more precise conversion, the following assumptions were made: 1) Antenna gains were measured at the two lowest frequencies, because it was felt that there might be substantial "proximity" effects from the cars and the ground at the lower frequencies. 2) For the highest three frequencies, the antenna factors supplied by the antenna manufacturer were used in the calculations. 3) In all cases, it was assumed

that the electric and the magnetic field components had the same relation as in a far-field measurement.

The fifth column of Table 2 contains an antenna factor, K_1 , which can be added to the rms level at the antenna terminal to give the rms field strength in dB above 1 microvolt. The sixth column of the table shows the measurements converted to rms field strength (in decibels above a microvolt/meter for a 10 kHz bandwidth).

The seventh column of Table 2 contains a factor, K_2 , which may be used to convert field strength to F_a , the effective antenna noise figure. F_a --given in the eighth column--is described more fully in the references and is generally most useful in calculations of system sensitivity (Spaulding, 1976). The formula used here,

$$F_a = E_n - 20 \log f_{\text{MHz}} - 10 \log b + 98.9,$$

is for an ideal quarter-wave dipole (Lauber, 1977). E_n is field strength (in dB>1μV/m) and b is bandwidth (in Hz). Other antenna types will require different conversion formulas.

In Figure 39, F_a is plotted as a function of frequency for the horizontal and vertical polarization antenna orientations with each of the two test configurations. The measurements made under identical sets of operating conditions have been joined, implying a relatively smooth curve joining the measured points. This may not be actually true; relatively large excursions might be found between the few points which actually were measured, caused by resonances at particular frequencies in the ignition systems.

Underneath the four sets of graphed data is a dashed line representing a background level of galactic noise. From the standpoint of noise being a problem to communications systems, it probably doesn't matter too much as long as noise remains below the galactic noise level. Galactic noise will remain relatively constant at the indicated level, furnishing an approximate lower limit to systems operating with low gain antennas. On the other hand, these measurements show that the cars were causing noise well in excess of galactic noise levels. Furthermore, the noise from the cars was very impulsive, causing occasional noise spikes which were very much higher than the Gaussian noise levels from galactic noise.

Finally, this set of measurements is a very limited set, and it would be ill-advised to conclude that these measurements describe a "typical" set of cars. Although the overall measurement accuracy at the antenna terminals is estimated to be within ± 2 dB, the variations in level arising from the selection of cars and in the orientation of the measurement antenna with respect to those cars is believed to be considerably larger than the bounds on measurement accuracy. Therefore, this set of measurements should be regarded as a single data point to be considered along with other measurement sets--withholding judgement until enough data has been measured that a pattern becomes visible.